by Professor Young in the solar corona. The lines C and F having already been observed, the discovery of the line G seems to render certain the existence of this gas in the Aurora. The common methods of interpolation were not available for computing the wave-lengths of column three, on account of the large interval between the lines. A curve was therefore constructed, in which vertical distances represented scale-readings, and horizontal distances the square of the reciprocal of the wave-lengths. This, by the formula of Cauchy, should be very nearly a straight line, giving, consequently, results of great accuracy.

EDWARD C. PICKERING

ON the evening of Monday, October 24, a very remarkable auroral display was observed in New York City. In the north at first was an obscure segment, low towards the horizon, surmounted by a pale glow of light. Later, this was replaced by an extensive manifestation of beautiful streamers.

But the most notable part of the phenomenon was a band of brilliant red light, varying in its different parts constantly throughout the evening, in brilliancy, definition, and breadth, but in general some ten degrees wide. It was seen early in the evening, and could be traced from within fifteen degrees of the horizon in the east and the west, extending entirely across the sky, south of the Zenith.

The position of this rosy band viewed from the south-east corner of the Central Park, was from 8¼ to 8½ p.m., New York City mean time, about as follows.

In the east, just above the horizon, passing almost centrally, and diagonally through the figure of *Cetus*, say between δ and ζ Ceti; thence going westward it lay between *Piscis occidentalis* and γ *Aquarii*, and between *Altair* and *Delphinus*, often expanding in width beyond these boundaries. Thence it extended westward to the stars in the heads of Hercules and Serpentarius nearly to the horizon.

In all its splendid variations throughout the evening, it maintained its position in regard to the horizon of the observer standing in the locality before mentioned, the diurnal motion of the earth carrying the stars past it.

On the following evening the exhibition of this red band, in the same position, was at least equally pronounced; but without any decided boreal light, so far as I have noticed or learned.

I would also here mention the very brilliant display of variously tinted auroral streamers which engaged the admiration of members of the American Association for the Advancement of Science, as they returned by the steamer on the Hudson to the city of Troy, from their visit to Albany, from ten to eleven o'clock on the evening of Friday, August 19, 1870.

JAMES HYATT

Honey Brook, Stanfordville P.O., New York

Early Mentions of the Aurora Borealis

YOUR correspondent, Mr. Earwaker, should have mentioned that the list of appearances of the Aurora Borealis given in M. de Mairan's work is chiefly derived from another enumeration in Prof. Frobes's "Nova et Antiqua Luminis atque Auroræ Borealis Spectacula," Helmstadii, 1739. On reference to this list it immediately appears that it is very little to be relied upon for displays previous to the year 1707 or thereabouts. Some of the appearances recorded rest on no good authority, others were obviously meteoric; some occurred within the Arctic circles, others are entered twice over from inadvertence, or a neglect to allow for the difference of style; more than twenty are recorded on the authority of the meteorological diary kept at Breslau by Grebner, who in fact says nothing more than that on those occasions the night was somewhat bright (*sublustris*). When the necessary deductions on these accounts have been made, it will be found that the infrequency of the phenomena prior to 1707, and its extraordinary development since that date, are well-established facts. They are strongly insisted upon by M. de Mairan himself, who does not produce more than five instances of the aurora in France during the whole of the seventeenth century, and shows from the evidence of a missionary that it was unknown or forgotten in China until 1718. All contemporary notices prior to about this period, attest the astonishment with which it was regarded.

From the following curious passage in Sirr's "Ceylon and the Cingalese" (vol. ii. p. 117), it would appear that the aurora, or something resembling it, is occasionally visible in Ceylon:—

"There is a heavenly phenomenon which appears occasionally in Ceylon, called by the natives Buddha lights; this faintly resembles the Northern Lights, and is extremely resplendent. The priests declare this to be a sign of Buddha's displeasure when his followers have become sinful in the extreme, and that the light appears over the wihare, from whence the priests suppose the phenomenon to emanate, where those who have committed the sin which has aroused the god's anger last worshipped."

London, November 19 R. G.

IN many parts of Ireland a scarlet aurora is supposed to be a "shower of blood." In 1854 while stationed at Bearhaven, County Cork, a scarlet aurora that then appeared was said to be the blood of the people that were slain at Balaclava. About two years ago, while driving between Oughterard and Clifden, at two o'clock in the morning, there was a magnificent scarlet aurora (by far the most brilliant I ever saw), on which the car-driver remarked, "I wonder, can that be the blood of the Americans?" The late aurora is said to be the blood of the Frenchmen.

In the old Annals showers of blood are recorded at different times, always in connection with a great battle or the murder of some great chief. The earliest I can remember is that of A.D. 688, in the "Annals of Cloonmacnoise," after a battle of the Leinster-men and Ossory-men (now in the King's County, but formerly in Munster), wherein Foylcher O'Moyloyer was slain. This battle and shower of blood in the "Annals of the Four Masters," is said to have happened in the year A.D. 690. These Annals also mention that butter was turned into the colour of blood and a wolf was heard to speak; while the Annals of Tighernach place the battle in A.D. 693, and say that the blood flowed in streams for three days and three nights. During the aurora I saw about two years ago, and the two nights that the last aurora was seen here, the lakes and rivers looked to be full of blood. Therefore I should imagine the aurora of 688 must have lasted three nights, and that the people who saw it and recorded it must have had butter for supper the night it was seen, which reflected the colour.

G. HENRY KINAHAN

Geological Survey of Ireland,
Connemara, Nov. 26

Prismatic Structure in Ice

THE following extracts from a letter from Mr. Langton (whose name was, unfortunately, misread as Langters in sending his former letter to the press) may interest others as much as it has done myself, if space can be found for it in your columns. In that case, perhaps, you will kindly allow me to say a few words in reply on a future occasion.

St. John's College, Cambridge T. G. BONNEY

"I admit with you that the prismatic structure of ice on the point of melting does not appear to have any connection with the hexagonal crystals in which it is formed; and that the great analogy between the conditions of ice in that state and of igneous rocks, and I may add of clay in the process of desiccation, seems to point to contraction as the common cause. But then arises the question whether ice really does contract as it approaches the melting-point, as we know that most melted mineral matter does on cooling, and clay on drying. I am quite willing to admit that it may do so, and that, as you observe, its demeanour at a point about 32° F. has not been accurately ascertained; but if so, the fact should first be determined from independent observations before drawing conclusions from it. I am willing also to admit that I spoke loosely in my former letter when I said that the air bubbles in the process of freezing seemed to be formed in vertical lines. My object, in the concluding sentence of that letter, was to express a doubt as to there being any such contraction as you suppose on the ice approaching the melting-point, and to point out the lines of air bubbles as being the immediate cause of the structure of rotten ice. I did not then go into the origin of the bubbles, or into the cause of their being thus found in vertical lines. It is difficult to suppose that they were originally formed in those lines, for though it seems natural that the air, which is always contained in water, should be excluded on its crystallising, there does not appear to be any sufficient reason why the bubble excluded to-day should be placed exactly under that formed yesterday. Upon reviewing the whole question, I am induced to think that, as will often happen, we were both right and both wrong: that you were right in attributing the prismatic structure originally to contraction, but wrong in supposing that contraction to be caused by an increase of temperature on the approach of the thaw, and that I was right in attributing the final break-up into prisms to the liquefaction spreading in every direction from the lines of air bubbles, but wrong in speaking of them as if they had originally been formed in those lines. We need not resort to a hypothetical contraction about the melting-point; we have a *vera causa* in accesses of cold, which will give you the desired contraction, and me my vertical lines of air bubbles. The true explanation I take to be as follows.

"After the ice has formed, and severe cold follows, it will contract, and probably equally in all directions. There is no impediment to its shrinking perpendicularly, as the whole sheet would then only be somewhat reduced in thickness; but the ice is entangled with the shores, and the whole sheet cannot contract horizontally, but relieves itself by a number of minute cracks. These are easily seen on the surface of glare ice, but one can hardly imagine that they do not more or less spread through the whole substance, and in your first letter you seem to say that you have noticed this after severe frosts. If then an air bubble comes near any such crack, it would seem natural that the direction of the crack should be diverted towards it. In fact the air bubbles, being weak points, would in a great measure determine the direction of these small fissures. Water would insinuate itself into them from below, carrying the air bubbles with it, which, upon the whole freezing, would not necessarily be exactly where they were before. A repetition of this process at frequent intervals during the winter would cause a rearrangement of the air bubbles, which one would naturally expect to find from this cause in more or less vertical lines. According to this explanation the prismatic structure would set almost from the first formation of the ice. The air bubbles would from the first be the indication of the direction of former fissures, and the lines which would determine that of new ones. As long as severe frosts continued, all other indications of the structure would be obliterated, but, as the temperature approached the melting-point, these lines of bubbles, as they formerly determined the direction of the fissures, would now be the weak points at which the thaw would commence pervading the whole mass.

"This explanation seems to supply everything that is wanted, and, upon looking back at your original letter, I am rather surprised, from the facts you mention, that you should have missed it. You say, 'I have seen it several times—in fact, *after every severe frost*.' This I have no doubt is correct; but why, then, do you say, lower down, that 'this finer structure may be found, if looked for, in *every tolerably gradual thaw*'? Again, you say that on one occasion you found the structure obliterated internally, 'except where some vertical lines of air bubbles marked the position of a tube or joint.' This exactly corresponds with what I have above supposed would be the process.

"Still, there are several points upon which more exact observations should be made before one can speak with any certainty upon the subject.

"1. Does ice contract on approaching 32° F.?

"2. Do air bubbles form from the first in vertical lines?

"3. Is there any indication, as the winter advances, of a rearrangement of the bubbles, as that they run into each other, and get more and more ranged in vertical lines?

"4. Is there any indication in the earlier stages of the ice, that, after a night's hard frost, the cracks seen on the surface spread through its substance? And if so, to what extent do they follow the lines of air bubbles?

"5. If a block of ice is cut early in the winter, before the prismatic structure from contraction with cold has commenced in any noticeable degree, and when it is no longer in a position in shrinking to crack in one direction more than another, to what extent does that structure afterwards develop itself?

"As there has been this one point in the behaviour of ice in which we have both taken an interest, I am induced to mention some other peculiarities which have come under my notice, with regard to some of which I have not even attempted to suggest an explanation. Several years ago I lived on the shores of a lake in the backwoods, and as in those early days the ice in winter and a canoe in summer formed one's only means of locomotion, one naturally thought a good deal about ice in its various stages of formation and decomposition. I lived about two miles below the head of the lake, where a river fell into it, upon which was a considerable fall, and which connected it with another much deeper lake, about a mile above. The effect of the stream was felt for a considerable distance into this lower lake, which was narrow at its head, and the ice was never safe there; indeed, excepting in the very severest frosts, there was as it were a bay of open water extending into the ice almost as far down as my house. But when the ice first formed in the fall it invariably took over the whole lake, even on that part which was afterwards open water during almost the whole winter. Indeed, upon one occasion, upon getting up in the morning I was astonished to see ice formed exactly on that part which was usually open water, whilst the rest of the lake, which was usually closed, had no ice upon it at all. Very soon after the sun rose that ice disappeared and the lake did not freeze over for a week after. The first ice, which always formed over the whole lake, would generally remain till there was a fall of snow on it, soon after which it would disappear where the effect of the stream was felt. The first winter I was there I nearly suffered from ignorance of this habit of the ice. I had occasion to cross the lake, which had been closed for some days, and had received a pretty thick coating of snow in the meantime, and, knowing that the ice must be pretty thin, I took the precaution to wear snow shoes. After a while I felt a peculiar sinking of the snow shoes, and observed that the track filled with water, and upon feeling with a stick I carried, I found no resistance of ice at all. I was, in fact, walking upon little more than a cake of snow. You may imagine that I at once made a little circuit and did not stop till my stick encountered good ice, and an hour or two afterwards that part of the lake was open water. Now I think I can explain this peculiarity of the early formation of ice where no ice remained during much colder weather in the winter. I take it that the whole surface, at least, of the water in my lake, which was rather a shallow one, had been reduced to 32° F., or nearly so, and that on a very cold night the water from above, being thoroughly exposed to the cold in coming over the fall, had been reduced even lower, so that when it reached the comparative quiet of the lake, where it naturally floated on the surface, it became ice for a short time that morning I spoke of, though it could not long maintain that condition. So also on ordinary occasions, when all the lower lake was ready to freeze, the water, thoroughly cooled at the fall, would freeze also, although the lake above had not yet been frozen over. At the foot of the upper lake, immediately above the fall, was a very shallow bar, so that the only part of the upper water which would come over would be the coldest layer on the top. But after the upper lake had frozen over also, and had received its coating of snow, very little more cold would penetrate to reduce the temperature of the surface, and the lake being very deep, and receiving fresh accessions of heat from below, the water would soon get considerably above the freezing-point, and with the aid of the friction of the stream would thaw away the snow-covered ice below with which it first came in contact. One is inclined to ask why the complete exposure of the water to the cold in coming over the fall, which I have supposed to reduce the temperature so much in the beginning of winter, had not the same effect in the severer cold afterwards; but the water which came from under the snow-covered ice would probably be much warmer than that which formerly came from the surface of the open water, and moreover the spray soon formed ice, which gradually crept over the shallower parts of the fall at its edges, and the exposure and its cooling effect may not have been as complete as at first. I cannot say that I am altogether satisfied with my explanation of the curious anomaly that a part of the lake would freeze over at a temperature of 20°, which would remain open when it was far below zero; but such are undoubtedly the facts.

"If there was this anomaly in the first formation of the ice, its sudden disappearance in the spring, which I mentioned in my former letter as giving rise to the popular prejudice that it sinks, was almost equally astonishing. Upon one occasion the ice was evidently in the last stage of decomposition, and I had got my canoe ready for a journey in the morning, when I fully expected the lake would be open; but before starting, I wanted to go to the two or three houses at the fall, which we dignified with the name of a village. Although the lake at my landing was an unbroken sheet of honeycombed ice, which had even borne me early in the morning, the open water extended to a point about half a mile above me, and I determined to carry my canoe so far through the woods. I cannot have been a quarter of an hour in doing so, but when I launched my canoe beyond the point, there was not a vestige of ice down as far as my landing, though I still saw it across the whole lake a little farther down. Being anxious to see the process of the actual disappearance, I turned my canoe down the lake, and paddled as fast as

I could; but long before I could get to where I had seen the ice, the whole lake as far as my view extended was open water. This almost instantaneous disappearance of a body of ice more than a foot in thickness can only take place in perfectly still weather. If there is any wind it breaks up, and the fragments are driven up against the ice which still holds together, and into the shores, where the rapidity with which it melts is not so striking. I never was fortunate enough to be actually in at the death.

"There are also some curious facts connected with the air-holes which form themselves during winter. There are often particular spots where partial openings in the ice will be formed every winter. These I conceive to arise from warm springs, and to have no connection with air-holes properly so called, which are not confined to any particular locality, but may appear anywhere. There is always a good deal of air under ice, and you may often see it scattered about in small bubbles when the ice is thin. It is probably air excluded in the process of crystallisation, and when there is added to it sundry gases formed from decaying matter in the water, it amounts during the winter to a considerable quantity. Such collections of air, like the bubble in a spirit-level, are in a very uneasy condition, and are rapidly transferred from one place to another on any casual disturbance of the level, giving rise to one of the numerous noises which are always more or less heard on a lake covered with ice—at least, we used always to attribute to this cause a peculiar groaning sound which was very common. Now, if there should be any casual inequality in the lower surface of the ice, the air will naturally collect there, and if it is above 32° F, which in so far as it consists of evolved gas it probably will be, the receptacle will be increased by thawing. A dome-shaped cavity will thus be gradually formed, which will finally reach the surface; air will escape from below, and the surface-water, of which there is almost always more or less after the snow has fallen, will run down from above, wearing the little jagged channels which are characteristic of air-holes. The whole thing will then after a while freeze up again, leaving an indication of where the air-hole has been in the different colour of the freshly-formed ice. I have tried several such air-holes with an axe when first formed, and have always found them to lead to such a dome-shaped cavity. I remember on one occasion an otter frequenting a large air-hole which remained open for some time, and which must have been from a mile and a half to two miles distant from the nearest open water. How did he reach it? for no otter can travel that distance under water without access to air. The Indians say that they will go to greater distances still under the ice, and that they always find air there. It is likely enough that there may be many such dome-shaped cavities, which have not yet reached, and may never reach, the surface as air-holes, but one would imagine the air they contain to be not of the most wholesome character. However, this otter did frequent that air-hole for about a week, which it certainly did not reach by travelling on the ice, and though it had few chances of breathing there, in the daytime at any rate, it contrived during that period to elude the snares of a white man and an Indian, who wasted a good deal of time in looking after it.

So far, the process of the formation of air-holes, if I am right in my explanation, is intelligible enough; but sometimes they are formed in a manner which is difficult to account for. Upon one occasion I had crossed the lake to a friend's house, about four miles off, and we had determined to start together next morning to our nearest town, but I had to go home first. I first went over by daylight, when there certainly was nothing unusual in the appearance of the ice, which might be four or five inches thick at the time, with a slight sprinkling of wettish snow on it. I returned home about eleven at night, and, as it was bright starlight, with only a few floating clouds, I should have noticed any change; but I came straight across, and saw nothing to attract attention. But when I crossed again at daylight in the morning, in one part of the lake the whole surface was covered with air-holes—there must have been hundreds of them. At first I gave them rather a wide berth, but, on approaching one to examine it, I found it frozen up again, the clear ice in the hole, with very slight indications of the characteristic jagged edges, being the only sign that there had been an open air-hole there during the night. I had no axe with me to try whether they were connected with any cavity, but the appearance was as if holes of from two to five or six inches in diameter had been punched through the ice. Of course, we attributed it to electricity, as people will do anything which they do not otherwise understand, and I have never been able to give any more intelligible explanation of the phenomenon. There certainly had been some faint sheet lightning that night, a very unusual thing in winter; but what connection, if any, there may have been between the two things, I cannot tell.

"Ottawa, Sept. 15" "JOHN LANGTON

The Difficulties of Natural Selection

I FIND, on looking again at Mr. Bennett's article, that I have misrepresented him on one point, for which I beg to apologise. On his supposition, that the first twenty possible steps on the road to mimicry are absolutely useless, his argument will have some weight. This supposition, however, is entirely unsupported by facts. Very large variations of colour are exceedingly common in butterflies; and when such variations are in the right direction, they must in some cases be useful. I believe myself that far less than fifty, or even twenty, steps of variation would in some cases produce very good mimicry.

ALFRED R. WALLACE

Cave-paintings by Bushmen

MY friend, Mr. George W. Stow, of Queenstown, South Africa, refers in a letter to the interesting subject of the old cave-paintings by the Bushmen, as follows: "During the last three years I have been making pilgrimages to the various old Bushman caves among the mountains in this part of the colony and Kaffraria; and, as their paintings are becoming obliterated very fast, it struck me that it would be well to make copies of them before these interesting relics of an almost extinct race are entirely destroyed. This gave rise to an idea in my mind of collecting materials enough to compile a history of the manners and customs of the Bushmen, as depicted by themselves. I have, fortunately, been able to procure many fac-simile copies of hunting scenes, dances, fightings, &c., showing the modes of warfare, the chase, weapons, disguises, &c. This promises to be a collection of very great interest. In some places it is astonishing to what a degree of perfection some of the wild artists had arrived. I have found three different series of paintings, one over the other; and, as the most recent must be upwards of fifty years old, the undermost are most probably very ancient. The colours are very permanent, and would last for ages if not wantonly obliterated. Unfortunately, the Kaffir herds and others are constantly destroying them, and, by the time another generation has passed, few remains of them will be left."

The pigments used in the caves were derived from ochreous concretions abounding in some of the sandstones of the Karoo series of the interior of South Africa, as in the Rhenosterberg, Stormberg, and elsewhere. These concretions, when broken open, supplied the natives with paint-pots, and from among the several colours of yellows, browns, reds, &c., the chocolate was selected for painting the human form in the caves.

T. RUPERT JONES

5, Terrace, Yorktown, Surrey

A Rare Fish

A SPECIMEN of the Silvery Hair-tail (*Trichiurus lepturus*) was taken this morning at Seaton. It measures 2 feet 2 inches in length, and is in very good preservation, being only slightly injured on one side of the head. A specimen from the Collection of the late Mr. F. W. L. Ross, in this museum, is about the same size, and was taken on 6th August, 1852, off the Start Point, Devon. The recorded instances in which this remarkable fish has occurred on the British coasts are very few, and the specimens obtained have generally been much injured. The present specimen was brought to me to name by Mr. Frank Gosden, of the West of England Fish and Game Company, Queen Street, Exeter. W. S. M. D'URBAN, Curator

Devon and Exeter Albert Memorial Museum,
Queen Street, Exeter, December 3

The Ceratodus Forsteri

I AM much obliged to Dr. Sclater for his remarks on the new fish discovered by me as *Ceratodus forsteri*, and I take this opportunity to inform your readers who may feel interested in this matter, that I spoke of the animal as an amphibian, principally because it is in the habit of leaving the water during the night. The works to which Dr. Sclater refers me are not at my command, and I adopted the generic term of *Ceratodus* because